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Harnessing wind energy at Manjil area located in north of Iran

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Abstract

Manjil is located in north of Iran and is capable of harnessing wind energy for electricity purpose. There are about six different stations in that region which all of them have excellent record of wind speed in different months of the year. It is one of the best locations in the world for installing wind turbine and the utility department has invested a lot of money to establish wind farms in this region. Statistical analysis for six different installed stations show that it is one of the best locations in the world for establishing wind farms. In this paper, wind speed at different sites in Manjil has been analyzed and it shows that it has a great potential for harnessing wind energy. So far, there has been only 51 wind turbines installed in the area and there is a plan to increases that amount in the future.

Keywords: Wind; Manjil; Energy; Speed; Potential

Contents

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1. Introduction

Iran (Persia) is situated in south-western Asia and borders the three CIS states, the Republic of Armenia, the Republic of Azerbaijan, and the Republic of Turkmenistan, as well as the Caspian Sea to the north, Turkey and Iraq to the west, the Persian Gulf and the Gulf of Oman to the south, Pakistan and Afghanistan to the east [1].

Manjil is located between N36°45′18″–N36°41′42″ and E49°23′6″–E49°31′48″. It is known as the windy city of Iran; a reputation caused by its geographical position in the Alborz mountains [2].

Manjil is situated about 220 km north-east of Teheran and 80 km south of the Caspian Sea in the province of Gilan. The wind conditions are characterized by average wind speeds of about 6 m/s (at 40 m measuring height above ground) in winter and by superb wind conditions especially in summer. The strong north-wind in the months from May to September with an average wind speed of 14 m/s (at 40 m above ground) and more can be explained with the local climatic and geographic circumstances [3]. Location and also the map of Iran have been shown in Fig. 1.

Manjil area has a great potential for capturing wind energy in order to convert it to electricity. It is also very important for development and economy of Manjil. It is one of the best locations in the world for installing wind turbine and the utility department has invested a lot of money to establish wind farms in this region. Roodbar is also another city close to Manjil in which there are total of 51 wind turbines in theses two areas. Because Iranian Renewable Energy Department plans to develop a national wind atlas, so there are two 10 m towers and also six 40 m towers installed to collect the wind speed at different locations in order to draw the wind map in the future.

Wind energy conversion systems for electricity generation and water pumping by direct mechanical means are techno-economically feasible in many locations of the country. The potential for wind power generation is estimated to be 6500 MW with the majority of the locations situated in the eastern and northern parts of the country. Manjil has winds that can result in as much as 1609 kWh/m^2 per year at the 40 m elevation above ground. The recent installation of a 600 kW wind turbine promises a reasonable growth for this technology in Iran [4].

In fact, contribution of the wind energy for production of electricity in Iran is very low. Its share is 0.04% which is almost negligible. But there are many suitable locations, which could be considered as wind farms in different parts of Iran for that purpose. Unfortunately, because of the low price of oil and gas in Iran, most of the electricity has been produced by fossil fuel in the past. There is a great concern towards renewable energies in Iran like wind and solar which government has put all its effort to expand wind and solar farms in different parts of Iran. As it is shown in Fig. 2, wind energy with 0.04%



Fig. 1. Map of Iran.

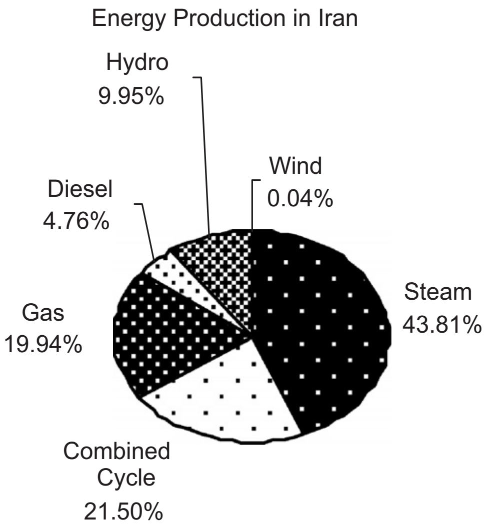


Fig. 2. Energy production in Iran [5].

contribution has almost no place in theses categories, but fossil fuel with 89.91% is the major supplier of electricity energy in Iran. There are many dams in Iran which produce electricity, but one of the major goals of Iranian government is to build dams in order to produce electricity. Iranian civil engineers also proved that they could build large dams recently. Iran is also capable of manufacturing large wind turbines in which some large wind turbines have been sold to Armenia by Iranian manufacturers recently.

2. Potential for wind energy in Iran

Studies show that wind energy production capacity in Iran is about 6500 MW. Power plants that are currently in operation are located in different windy locations of Iran.

Table 1
Turbines in Manjil and Roodbar area

No.	No. of turbines	In kW
1	3	660
2	18	550
3	2	500
4	27	300
5	1	600
Total	51	2610

Manjil and Roodbar are among the best sites for capturing wind in south of Caspian Sea. For the time being, there are only six stations which are capable of producing electricity by wind turbines [3]. As a matter of fact, most of the turbines are in Manjil and Roodbar areas. The total number of installed turbines in different parts of Iran up to 2006 based on information from Iranian Renewable Energy Agency till end of 2005 is 59 in which 51 of them are in Manjil and Roodbar, five in Binalood, two in Dizbad and one is in Tabriz. The properties of installed turbines in Manjil and Roodbar areas are depicted in Table 1.

As a matter of fact, there are three sizes of turbines in the world which are small, middle and big size. Small-sized turbines are being used in remote areas in which there are no access to national power network like islands and small remote villages. These turbines have potential to produce up to 10 kW of electricity. But in Iran nobody has paid attention to this size of turbine seriously yet. Middle-sized turbines produce between 10 and 250 kW electricity which in some areas of Iran we could see this size turbines rarely. Large wind turbines which produce more than 250 kW electricity are common in Iran and being used in most windy areas. These turbines are designed independently or connected to the network [1].

3. Measured wind speed for Manjil

There are six stations which are located at Manjil area in order to evaluate the wind speed in different elevations. The speed of wind had been measured at elevations of 10, 20 and 40 m too. It goes without saying that Manjil has a great potential for capturing wind and it is the best region for investing in wind turbine business. So far the government had installed turbines and there is a plan to inform people about wind business in order to invest money for wind farms. In Table 1, there are six stations that are located at Ali Abad, Babaeian, Jarandagh, Esfestan, Jirandeh and Mirkhoond. The wind speed has been measured for 12 months [6]. The Manjil area provides constant high wind velocity due to its mountainous topography and it is one of the most important sites for harnessing wind energy.

Fig. 3 shows the average wind speed for six different stations in Manjil area. As it is shown in the given figure, Ali Abad with an average wind speed of 9.2 m/s is the best-known site in area.

4. Statistical analysis for installed stations of Manjil area

There are six different locations in Manjil area in which there are some wind turbines installed. These six stations are among the best sites for harnessing wind energy, because in

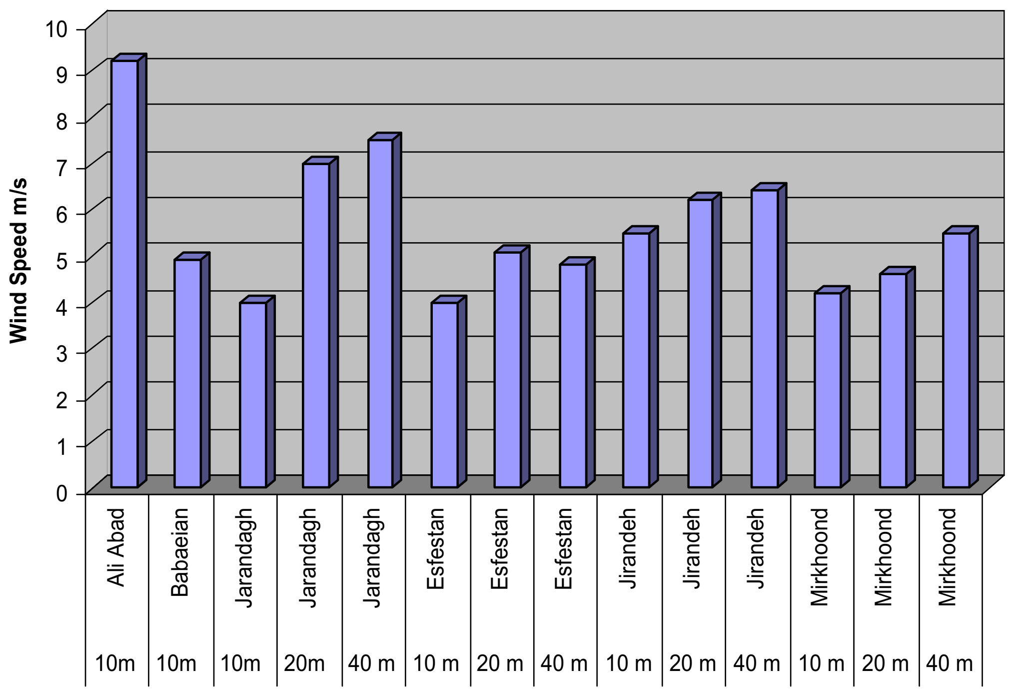


Fig. 3. Average wind speed in different locations of Manjil.

different months the acceptable blow of wind exists. Existing stations at Manjil are Ali Abad, Babaeian, Jarandagh, Esfestan, Jirandeh and Mirkhoond.

4.1. Ali Abad station

Ali Abad is among the best location with an average wind speed of 9.2 m/s. The highest speed is 15.9 m/s in July, but the lowest speed is 4.5 m/s in February which shows that there is an acceptable wind potential in different months of the year. These information have been gathered at elevation of 10 m, but if we convert it to an elevation of 40 m, then the result would be amazing. The wind speed at 40 m elevation is more than 10 m, because of the roughness at the surface of the earth. The trees, houses, hills and others cause turbulence at low elevation which we could see lower speed, but at higher elevation the wind has higher speed. Ali Abad station was established in 2000 with capability to measure wind speed at only 10 m elevation. It is also 620 m above the sea level. As a matter of fact, at 40 m elevation, the wind speed would be much higher than this given data for 10 m (Fig. 4).

4.2. Babaeian station

Babaeian with a yearly wind speed average of 4.9 m/s is also another location in Manjil area. As it is shown in the graph, the lowest speed of wind is 2 m/s in June which we could still use some turbines for converting wind energy to electricity. Babaeian station was

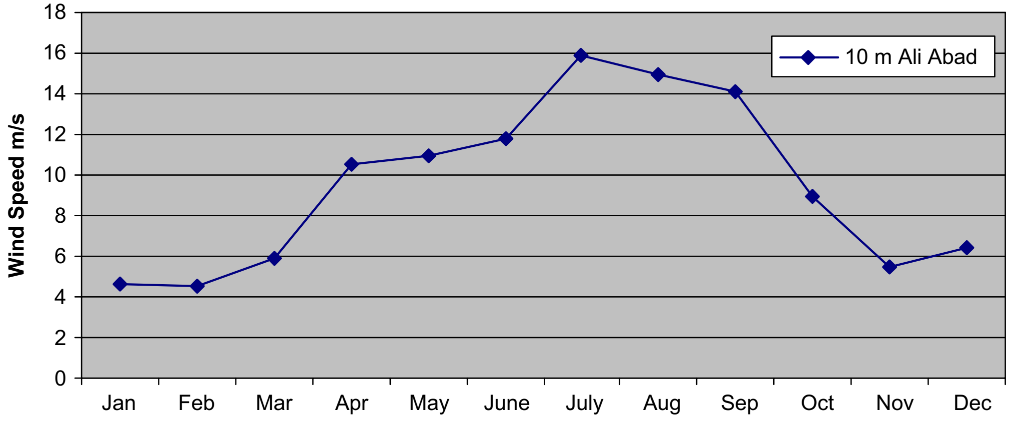


Fig. 4. Wind speed for different months at Ali Abad.

established in 2000 with capability to measure wind speed at only 10 m elevation. It is also 467 m above the sea level. As a matter of fact, at 40 m elevation, the wind speed would be much higher than this given data for 10 m (Fig. 5).

4.3. Jarandagh station

Jarandagh with an average wind speed of 7.5 m/s at 40 m elevation is also a very good station for installing wind turbines. The average wind speed at 10 m elevation is 4 m/s and for 20 m elevation is 7 m/s. The lowest speed is in January and the highest is in the month of August. Actually, the speed of wind at ground level is less than 10 m elevation. Also wind speed at 20 m is more than 10 m. As higher elevation, the wind speed in most stations is higher. Based on statistical analysis from Jarandagh station, there is a direct correlation between elevation and wind speed. The amount of wind speed in different months depend on earth topography of region, location, elevation from see level and time period of blowing wind in the area. In general, Jarandagh is a perfect location for capturing wind for rotation of blades (Fig. 6).

4.4. Esfestan station

Esfestan with an average yearly wind speed of 4.8 m/s at 40 m elevation is also another good station in the region. The weakness of this site is that of high wind speed in May and June, so it would cause serious damage to the turbines and it needs necessary precaution action. As it is shown in Fig. 7, wind speed at 40 m elevation most seasons is less than 20 m. It is an unusual situation which depends on roughness of the area and topography of earth. Still at higher elevation, there is an acceptable wind which could be captured for turbines. Big difference in wind speed is in May but there is a little difference in remaining months.

4.5. Jirandeh station

Jirandeh with an average yearly wind speed of 6.4 m/s at 40 m elevation is a good station for the purpose of capturing wind energy too. There is a sharp rise of wind speed in July

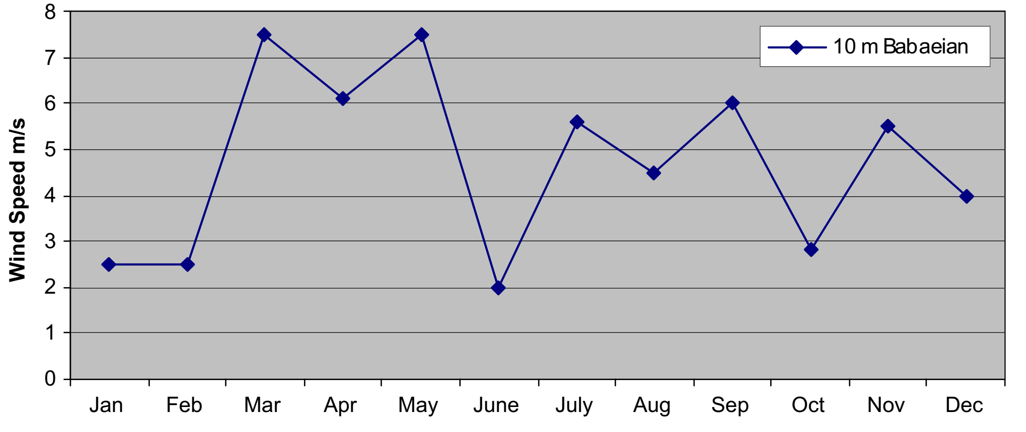


Fig. 5. Wind speed for different months at Babaeian.

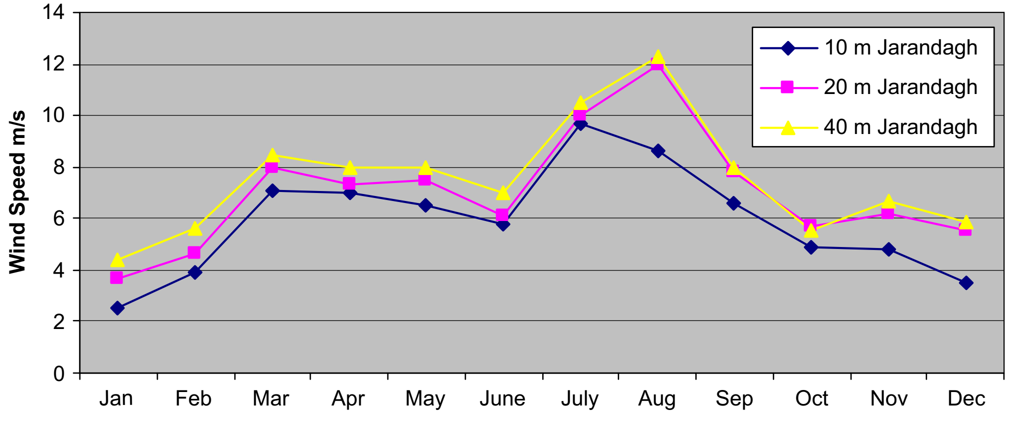


Fig. 6. Wind speed for different months at Jarandagh.

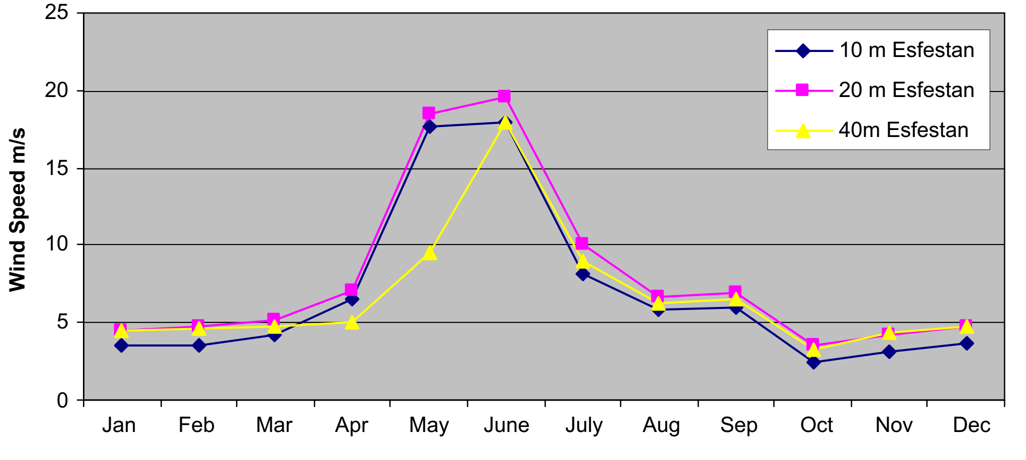


Fig. 7. Wind speed for different months at Esfestan.

and August, but it is not serious to damage the blades. The range of wind speed for other months is acceptable. As it is shown in Fig. 8, there is a direct correlation between elevation and wind speed. The amount of wind speed in different months depend on earth topography of region, location, elevation from see level and time period of blowing wind in the area. It is a good location for medium size turbine in order to generate electricity.

4.6. Mirkhoond station

Mirkhoond with an average yearly wind speed of 5.5 m/s at 40 m elevation is also another location in Manjil area. There is a sharp rise of speed in July, but it is only 10.8 m/s which cannot be considered as a destructive factor. As it is shown in the figure, wind blows in all different months which is a good point to mention about Mirkhoond too. There is a direct relation between wind speed and elevation, as it is shown in Fig. 9. Mirkhoond is not

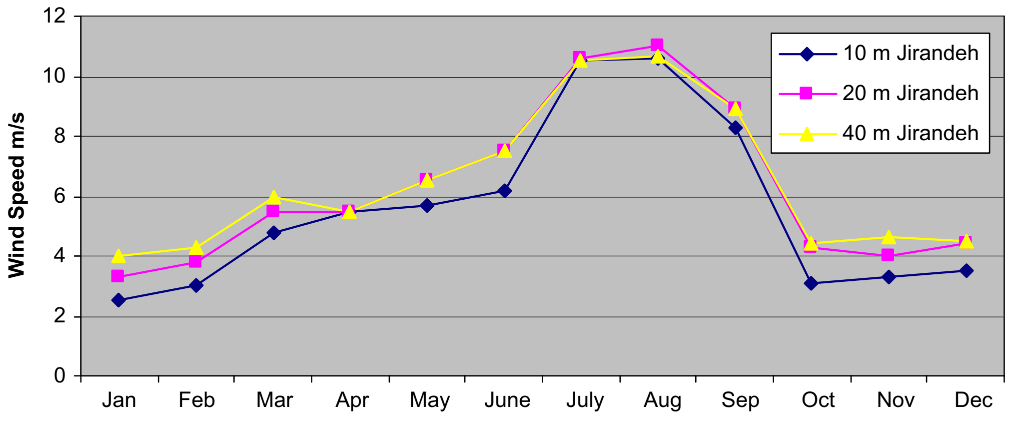


Fig. 8. Wind speed for different months at Jirandeh.

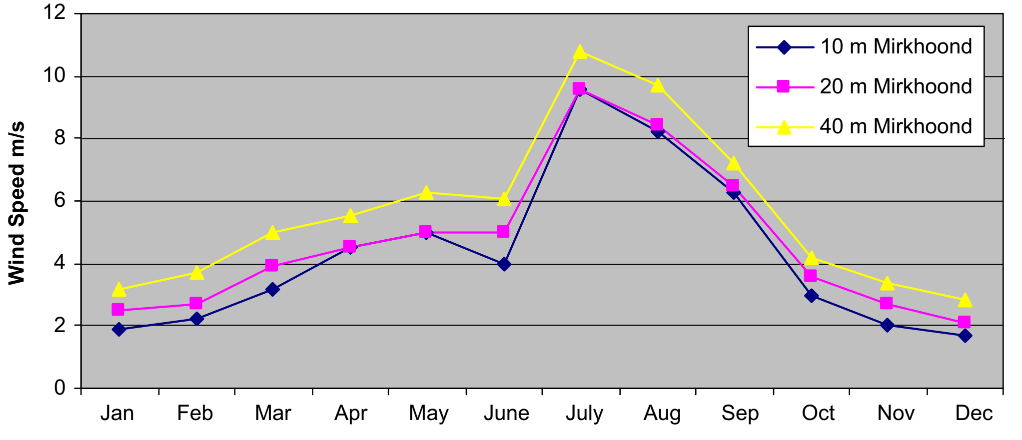


Fig. 9. Wind speed for different months at Mirkhoond.

a perfect site for wind turbine, but its advantage is continuous blow of wind in different months. It could also be used for medium- and small-sized turbines.

5. Conclusion

The contribution of wind turbines in the production of electric energy in Iran is very low, only 0.04%, but it is possible to increase the share of wind energy for energy purposes. Manjil is one of the locations in Iran which is suitable to install wind turbines. Government has paid a great attention to establish wind farms in different good locations in Iran, but Manjil is one of the best locations. Iran is also capable of manufacturing most parts of wind turbines. It should be mentioned that its price is lower than other countries too. In Manjil, there are only 51 wind turbines installed yet and there is a plan to increase that amount in the future.

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